

Factors Associated with Pelvic Fractures in Polytrauma Patients with Orthopaedic Injuries

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ABSTRACT

Objective: To calculate the proportion of pelvic fractures in patients admitted to the emergency department due to polytrauma and to reveal the associated risk factors.

Methods: A total of 200 polytrauma patients with orthopaedic injuries were retrospectively evaluated. Demographic data such as age, gender, mechanism of injury, fracture locations, the Injury Severity Score (ISS), and the operation status of all patients were recorded. Fractures were categorized according to their anatomical locations: lower extremity fractures, upper extremity fractures, and pelvic fractures.

Results: Among the patients, 79 (39.5%) had lower extremity fractures, 112 (56%) had upper extremity fractures, and 57 (28.5%) had pelvic fractures. Statistical analysis revealed significant correlations between the presence of pelvic fractures and female gender ($P = 0.005$), higher ISS scores ($P = 0.005$), the absence of requirement for surgery or fracture fixation ($P < 0.001$ for each), and the absence of upper and lower extremity fractures ($P < 0.001$ and $P = 0.002$, respectively). Detailed risk analysis was conducted after 2 x 2 cross tabulations were constructed, and it revealed that female gender, no requirement for surgery or fixation, and absence of upper or lower extremity fractures are associated with an increased likelihood of pelvic fractures among victims of polytrauma.

Conclusion: The estimated proportion of pelvic fractures in patients with polytrauma and associated orthopaedic injuries is 28.5%. In this selected cohort of polytrauma patients with concomitant orthopaedic injuries, the absence of upper- and lower extremity fractures requiring surgical fixation was associated with pelvic fractures. However, this finding should be interpreted cautiously in light of potential patient selection bias and the influence of post-injury surgical decision-making. Further studies incorporating multivariable analyses are needed to clarify these associations.

Keywords: Polytrauma, pelvis, trauma

INTRODUCTION

Traumas are among the most common causes of morbidity and mortality worldwide.¹⁻³ The most common causes of polytrauma include high-energy injuries, such as traffic accidents, falls from height, and gunshot wounds. However, it may also be observed after low-energy injuries in elderly individuals or in individuals with osteoporotic bone structure.^{4,5} Polytrauma is defined as simultaneous, severe injury to at least two body regions or

organs.²⁻⁶ Pelvic fractures are of particular significance in such cases, given their association with hemodynamic instability and concomitant organ injuries. Indeed, pelvic fractures are the most common cause of death following brain injury in patients with polytrauma.⁷

Pelvic fractures, defined as fractures within the pelvic region, typically arise from high-energy injuries. These fractures are challenging to monitor and treat due to their complex



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anatomy. They may manifest as isolated injuries or as part of a multifaceted trauma pattern. Expeditious detection and prompt intervention are paramount to the patient’s prognosis and to the management of the injury. Displaced or dissociated pelvic fractures have been shown to cause severe hemodynamic instabilities^{2,4,5} while non-displaced or minimally displaced pelvic fractures attract less attention. Although fragmented, comminuted, or unstable pelvic fractures can be readily identified by physical examination or direct anteroposterior radiography, fissures of the iliac wing or fractures of the pubic rami may initially be overlooked, particularly in cases of polytrauma. However, these relatively minor injuries may result in secondary comorbidities due to delayed mobilization and the consequent need for anticoagulant therapy arising from immobilization. The challenge in managing these non-displaced fractures arises from the tendency of healthcare professionals to prioritize the treatment of more visible and urgent injuries, potentially overlooking these less conspicuous yet significant cases. This underscores the paramount importance of identifying pelvic fractures in patients with polytrauma. However, studies that evaluate the association between pelvic fractures and other orthopaedic injuries, as well as the predictability of such fractures, are scarce. The objective of the present study was to calculate the proportion of pelvic fractures among patients admitted to the emergency department for polytrauma and to identify fracture relationships associated with increased risk of pelvic fracture.

MATERIALS AND METHODS

Study Population and Data Collection

Following the approval of the University of Health Sciences Türkiye, Ankara Bilkent City Hospital Clinical Research Ethics Committee (decision no: TABED 1-25-1337, date: 04.06.2025), all patients who presented to the emergency department of the study center between 2019 and 2020 with a diagnosis of polytrauma, including orthopaedic injuries, and who were referred to the orthopaedics and traumatology clinic were investigated, regardless of the treatment method applied. Due to the retrospective nature of this study, the requirement for informed consent was waived. The inclusion criteria for the study were polytrauma, defined as injuries in more than one system,

and orthopaedic fractures. Patients who were referred to the orthopaedic clinic for other reasons (e.g., forensic necessity) and patients with severe soft tissue injuries without underlying fractures were excluded from the study. Pelvic fractures were evaluated and confirmed using computed tomography. Only pelvic ring fractures were included in the pelvic fracture group; acetabular fractures were excluded. Within the specified date range, 200 patients were retrospectively evaluated according to the inclusion and exclusion criteria.

Evaluation of the Patients

Demographic data of all patients, such as age, gender, mechanism of injury, fracture localization, the Injury Severity Score (ISS), and operation status, were recorded. The injury mechanisms were categorized under two subheadings: low-energy injuries (e.g., fall after sprain with accompanying head trauma, fall from pavement, fall from stairs with less than three steps, assault) and high-energy injuries (e.g., fall from height, traffic accidents, motorcycle accidents, firearm injuries). Fractures in all patients were categorized according to anatomical location: lower extremity fractures, upper extremity fractures, and pelvic fractures.

ISS is a system used to determine the severity of polytrauma (Table 1).^{2,3,8,9} It is one of the most commonly used anatomical scoring systems in this field. First, the severity of the injuries to the six body regions was determined using the Abbreviated Injury Scale (AIS). The ISS is calculated as the sum of the squares of the AIS scores of the three most seriously injured anatomical regions (i.e., the three anatomical regions with the highest AIS scores) (Table 1). Although the ISS can theoretically range from 1 to 75, any anatomical region with an AIS score of 6 automatically results in an ISS of 75. An AIS score of 6 indicates maximal injury severity (currently untreatable). After initial hospitalization, all patients were also evaluated for the need for surgery performed for any reason by a clinic other than orthopaedics and traumatology. Procedures that could be performed in the emergency department, such as chest tube insertion, were not categorized as surgical interventions. Requirements for fracture fixation were also recorded. To ascertain the need for operation and fixation, only surgeries performed at the time of initial hospital admission were considered; surgical requirements during subsequent follow-up were disregarded.

MAIN POINTS

- The proportion of pelvic fractures among polytrauma patients with concomitant orthopaedic injuries was 28.5 percent.
- Pelvic ring fractures were significantly associated with female sex and elevated Injury Severity Scores.
- The absence of concomitant upper or lower extremity fractures and the lack of need for emergency surgical fixation were paradoxically identified as significant clinical indicators of pelvic injury.
- Clinicians should maintain a high index of suspicion for severe pelvic trauma in polytrauma patients, particularly those lacking overt extremity fractures.

Table 1. Injury Severity Score and Abbreviated Injury Scale

Anatomical regions	Abbreviated Injury Scale (AIS)
Head-neck	Minor
Skin-soft tissue	Moderate
Face	Serious but not life-threatening
Thorax	Serious and life-threatening
Abdomen	Critical, survival doubtful,
Extremity-pelvis	Maximal (currently untreatable)
Injury Severity Score, sum of the squares of the 3 highest AIS scores.	

Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics (version 25.0, IBM Corp., Armonk, NY, USA). The investigation of the data revealed that both the "age" and "ISS" parameters were not normally distributed. Consequently, median, interquartile range (IQR), and minimum and maximum values were used to describe these parameters, while categorical data were summarized as frequencies (percentages). The analysis of categorical parameters was conducted using the chi-square test, while Fisher's exact test was employed when the chi-square assumption was not met. For risk analysis, 2 x 2 cross-tabulations were constructed and odds ratios (ORs) were computed with 95% confidence intervals. A *P* value less than 0.05 was considered statistically significant.

RESULTS

The median age of the patients included in the study was 41 years (IQR: 38; range: 2-95 years), and the median ISS score was 16.5 (IQR: 16; range: 4-75). Of the patients, 79 (39.5%) had lower extremity fractures, 112 (56%) had upper extremity fractures, and 57 (28.5%) had pelvic fractures. A total of 76 (38%) patients underwent surgical intervention for fracture care. Detailed patient data are shown in Table 2.

Statistical analysis revealed significant correlations: the presence of pelvic fractures was significantly associated with female gender (*P* = 0.005), higher ISS scores (*P* = 0.005), absence of requirement for surgery or fracture fixation (*P* < 0.001 for each), and absence of upper and lower extremity fractures (*P* < 0.001 and *P* = 0.002, respectively) (Table 3). Detailed risk analysis was conducted after 2 x 2 cross tabulations were constructed, which revealed that female gender, absence of requirement for surgery or fixation, and absence of upper or lower extremity

fractures were associated with an increased likelihood of pelvic fractures in victims of polytrauma (OR: 1.87, 95% CI: 1.22-2.87; OR: 2.3, 95% CI: 1.33-4; OR: 2.88, 95% CI: 1.55-5.36; OR: 3, 95% CI: 1.83-4.91; and OR: 2.21, 95% CI: 1.28-3.83) (Table 4).

DISCUSSION

Determining the relationship between pelvic fractures and demographic characteristics, as well as other fracture types in polytrauma, will facilitate early diagnosis and rapid intervention. While fractures of the pelvis that are fragmented, comminuted, or unstable can be readily identified through physical examination or direct anteroposterior radiography, fissures of the iliac wing or fractures of the pubic rami may initially be overlooked, particularly in cases of polytrauma. However, these relatively minor injuries can potentially result in secondary comorbidities due to the delay in mobilization and the necessity of blood thinners, which arises from the immobilization. Therefore, it is important to determine which fractures or patient characteristics are more likely to be associated with these minor injuries that may be overlooked in polytrauma patients. In this way, high-risk patients can be identified and necessary evaluations can be conducted. This is the most important aspect of our study. Our most important finding was that female gender, higher ISS score, the absence of a requirement for surgery or fixation, and the absence of upper or lower extremity fractures were associated with an increased likelihood of pelvic fractures in victims of polytrauma. The prevalence of pelvic fractures ranges from 2% to 8% of all fractures, with literature on polytrauma cases indicating increases of up to 25%.^{10,11} In this study, the proportion of pelvic fractures in patients with orthopaedic injuries was 28.5%, indicating that approximately one in every four patients with orthopaedic injuries had a pelvic fracture. The median ISS in the present cohort was 16.5 (IQR:

Table 2. Demographic characteristics and fracture distribution of polytrauma patients

	Number of patients (n)	Percentage (%)
Age (years)*	41 (38) (2-95)	
Gender	Female	65
	Male	135
Injury Severity Score*	16.5 (16) (4-75)	
Mechanism of injury	Low-energy	48
	High-energy	152
Requirement for surgery	Yes	81
	No	119
Requirement for fracture fixation	Yes	76
	No	124
Lower extremity fracture	Yes	79
	No	121
Upper extremity fracture	Yes	112
	No	88
Pelvis fracture	Yes	57
	No	143

*median (interquartile range) (minimum-maximum range was used as descriptive statistics. n, number of patients.

Table 3. Factors Associated with Pelvic Fractures Among Polytrauma Patients with Orthopaedic Injuries

		With pelvic fractures (n=57)	Without pelvic fractures (n=143)	P
Gender	Female	27 (41.5%)	38 (58.5%)	0.005
	Male	30 (22.2%)	105 (77.8%)	
Age (years)		50 (36) (4-94)	40 (38) (2-95)	0.116
Injury Severity Score		18 (18) (8-75)	13 (14) (4-75)	0.005
Mechanism of injury	Low-	9 (18.8%)	39 (81.3%)	0.086
	High-	48 (31.6%)	104 (68.4%)	
Requirement for surgery	No	44 (37%)	75 (63%)	0.001
	Yes	13 (16%)	68 (84%)	
Requirement for fracture fixation	No	47 (37.9%)	77 (62.1%)	<0.001
	Yes	10 (13.2%)	66 (86.8%)	
Lower extremity fracture	No	44 (36.4%)	77 (63.6%)	0.002
	Yes	13 (16.5%)	66 (83.5%)	
Upper extremity fracture	No	40 (45.5%)	48 (54.5%)	<0.001
	Yes	17 (15.2%)	95 (84.8%)	

n, number of patients; p, statistical significance value.

Table 4. Odds Ratio Analysis of Factors Associated with Pelvic Fractures in Polytrauma Patients

		With pelvic fractures (n=57)	Without pelvic fractures (n=143)	P	OR (95% CI)
Gender	Female	27 (41.5%)	38 (58.8%)	0.005	1.87
	Male	30 (22.2%)	105 (77.8%)		(1.22-2.87)
Requirement for surgery	No	44 (37%)	75 (63%)	0.001	2.3
	Yes	13 (16%)	68 (84%)		(1.33-4)
Requirement for fracture fixation	No	47 (37.9%)	77 (62.1%)	<0.001	2.88
	Yes	10 (13.2%)	66 (86.8%)		(1.55-5.36)
Lower extremity fracture	No	44 (36.4%)	77 (63.6%)	0.002	2.21
	Yes	13 (16.5%)	66 (83.5%)		(1.28-3.83)
Upper extremity fracture	No	40 (45.5%)	48 (54.5%)	<0.001	3
	Yes	17 (15.2%)	95 (84.8%)		(1.83-4.91)

n, number of patients; p, statistical significance value; OR, odds ratio; CI, confidence interval.

16; range: 4-75). According to the extant literature, an ISS score greater than 15 is typically indicative of severe or major trauma, with a concomitant significant increase in mortality risk within this cohort.¹² Our median ISS score suggests that major trauma was more prevalent in our cohort. The association between pelvic fractures and higher ISS should be interpreted cautiously, as pelvic injuries themselves contribute directly to the ISS calculation. Therefore, this association may partly reflect the structure of the scoring system rather than an independent predictive relationship.^{2,3,8,9}

In the present study, female gender was significantly associated with pelvic fractures ($P = 0.005$, OR: 1.87, 95% CI: 1.22-2.87). This association can be attributed to the anatomical and biomechanical differences inherent in the female pelvis. The existing literature supports the notion that the prevalence of pelvic fractures is significantly higher in women than in men and that this may be related to decreased bone mineral

density. A higher prevalence of osteoporosis in women has been suggested as a possible cause of increased susceptibility to pelvic fractures.¹³ In a study by Demetriades et al.,¹⁴ reported that pelvic fractures showed a higher prevalence in women and this could be explained by biomechanical and hormonal factors. However, there are also studies in the literature indicating that pelvic fractures resulting from high-energy trauma are more common in male patients.^{15,16} This contradiction may be attributable to differences in study populations and sample sizes.

In the present study, the absence of concomitant fractures of the upper and lower extremities among patients with pelvic fractures was statistically significant. This finding is hypothesized to be related to the mechanism of injury. One possible explanation is that the initial point of impact may influence the distribution of injury energy and the resulting skeletal damage. It can be hypothesized that patients who

sustain the initial impact to an extremity may have a lower probability of concomitant pelvic fractures, whereas patients who experience a direct blow to the pelvis may have a lower probability of concomitant extremity fractures. However, this proposed mechanism remains hypothetical and cannot be confirmed by the present retrospective data. The extant literature on the subject is largely consistent, and pelvic fractures are found to be associated with abdominal, thoracic and genitourinary injuries, rather than upper and lower extremity fractures.^{2,17-19} Martínez et al.¹⁷ reported that pelvic fractures frequently occurred in conjunction with costal fractures and spinal injuries as a result of high-energy traumas. Figler et al.¹⁸ demonstrated that the bladder and urethra were the most frequently injured organs due to their position in the pelvis. In a study by Giannoudis et al.,¹⁹ 21.2% of patients with pelvic ring injuries had chest trauma, 16.9% had head injuries, and 7.8% had two or more long bone fractures. The most common injury accompanying pelvic fractures was not analyzed in this study. This is one of the study's limitations.

The correlation identified in the present study between the absence of fracture fixation and the occurrence of pelvic fractures can be interpreted as a consequence of the association between pelvic and extremity fractures. Musculoskeletal injuries represent the most prevalent indication for surgical intervention in polytrauma patients, with Balogh²⁰ documenting that 70% of patients with polytrauma necessitated orthopaedic surgical procedures. The literature has demonstrated that the number of surgeries increases in the presence of extremity injuries in polytrauma patients, and lower extremity fractures usually require surgical intervention.²¹ Because the absence of upper and lower extremity fractures increases the frequency of pelvic fractures in polytrauma, an association between the absence of a requirement for surgery or fixation and pelvic fractures is expected. Considering the relationship between pelvic fractures and genitourinary, abdominal, and thoracic injuries, pelvic fractures are expected to be directly related to the need for surgery. However, in our study, "the absence of requirement for surgery" increased the proportion of pelvic fractures by 2.3 times. We believe that this situation is not related to displaced or unstable fractures of the pelvis, but rather to minor injuries such as pubic ramus fractures or iliac crest fissures. In other words, we believe that the increased pelvic fracture rate in the absence of a need for surgery is due to minor pelvic injuries. It is important to note that the pelvic fractures were not classified in our study and that we examined these minor and major/displaced/unstable fractures under the same heading, which constitutes a limitation of the study.

Study Limitations

The retrospective design of the study and the limited sample size are the most significant limitations. The inability to perform subgroup analyses by pelvic fracture type is a significant limitation. The analysis could not be performed because of the limited number of patients, reliance on retrospectively collected screening data, and missing data in patient files. Furthermore, the inclusion of only polytrauma patients with orthopaedic fractures may have introduced selection bias, while

the absence of multivariable analysis and the influence of post-injury surgical decision-making limit the interpretation of the observed associations as independent risk factors or predictors. A further significant limitation of the present study is that it did not examine subsequent outcomes of pelvic fractures, nor did it include a mortality analysis, despite the acknowledged high correlation between pelvic fractures and mortality. However, given that the primary focus of the study was on the presence of pelvic fractures, these analyses were not conducted.

CONCLUSION

The estimated proportion of pelvic fractures among patients with polytrauma and associated orthopaedic injuries is 28.5%. In this selected cohort of polytrauma patients with concomitant orthopaedic injuries, the absence of extremity fractures requiring surgical fixation was associated with the presence of pelvic fractures. However, this association should be interpreted cautiously, considering the potential influence of patient selection and subsequent surgical decision-making. Further prospective, multicenter studies with larger cohorts are needed to better understand these associations and assess their independent significance.

Ethics

Ethics Committee Approval: Ethics committee approval was obtained from the University of Health Sciences Türkiye, Ankara Bilkent City Hospital Clinical Research Ethics Committee (decision no: TABED 1-25-1337, date: 04.06.2025).

Informed Consent: Informed consent was waived due to the retrospective nature of the study. Permission to use patient data was obtained from the hospital management.

Footnotes

Author Contributions

Concept Design – C.Ç., S.S., A.Y., B.G., Ö.D.; Data Collection or Processing – C.Ç., S.S., A.Y.; Analysis or Interpretation – C.Ç., S.S., A.Y., B.G., Ö.D.; Literature Review – C.Ç., S.S., A.Y.; Writing, Reviewing and Editing – C.Ç., S.S., A.Y., B.G., Ö.D.

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